Iannis Xenakis:Architect of Light and Sound

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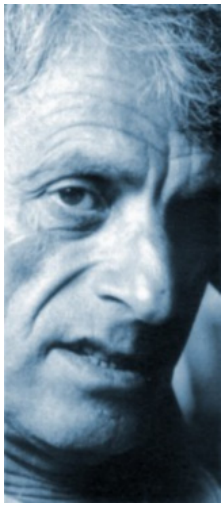
Iannis Xenakis:Architect of Light and Sound

Alessandra Capanna summarizes the life and work of Iannis Xenakis, who passed away on 4 February 2001.He was a musician, but above all he was a theorist and pure researcher who used mathematical thought as a basis for of his compositions. Because of this, his way of working more closely resembles that of a philosopher of science than that of an artist, whose instinctive creations are sometimes controlled only by aesthetical aims. he was also an architect. In 1956 Le Corbusier entrusted his sketches for the Philips Pavilion for the Brussels World's Fair to Xenakis, who was charged to "translate them through mathematics".

On February 4th one of the most famous contemporary musicians – as celebrated as Pierre Boulez and Karlheinz Stockhausen – died. He was a musician, but above all he was a theorist and pure researcher who used mathematical thought as a basis for of his compositions. Because of this, his way of working more closely resembles that of a philosopher of science than an artist, whose instinctive creations are sometimes controlled only by aesthetical aims.



I am writing about Iannis Xenakis[1] (Figure 1, left), an uncommon man and the kind of composer who embodies the ideal of an "architect of music". This characterization has been attributed to many great composers of the past from Brahms to Schönberg to Bach, but it particularly fits Xenakis, not only because he worked as architect for twelve years in Le Corbusier's atelier in Paris – during his first experiences as composer of a new musical genre – but mainly because of his tendency to appropriate for himself a demiurgical style through his philosophical speculations on the concepts of symmetry, the masses and space-time.

His social and cultural development took place in the 1940s, the years of the Greek civil war. His restless personality developed in the impetuous climate of the Polytechnic in Athens, where he formed a tormented personality for which interest in politics was not only a necessity, but was fed by the deep-seated sense of being a Greek. Thus the sometimes tragic events relating to the cruel and ferocious fighting in the streets fused with a maniacal reading of Plato's *Republic* and, especially in the second part of his life, to a swelling neo-Pythagoreanism.

Xenakis was among the components of Le Corbusier's atelier immediately after the second world war. He is mentioned in *Modulor 2* as the author of studies on the *pans de verre ondulatoires*, in relation to the musical research that was connected to *Metastasis*, his first work for orchestra; he figures in the list of collaborators that Jean Petit put together for his book on Le Corbusier; he was one of the protagonists of the renewed interest in the close relationships between architecture, music and mathematics. Those who introduce Xenakis as an ancient Greek born by chance in our modern world, while perhaps availing themselves of a romantic image, nevertheless describe the characteristic features of a man concerned with ancient mathematical subjects, interest in which has never entirely died out. It was about these subjects that, in our century, Matila Ghyka wrote *The Geometry of Art and Life*, in which he asserts that a certain

thread of Greek culture – perhaps the most esoteric of Pythagorean thought – crosses western culture like an underground river. This river certainly flowed in the studio of rue de Sèvres where, at the end of 1947, the young Xenakis found fertile humus for his compositional obsessions. In particular, his teacher's lessons on geometric "regulating lines" – one of the essential keys to Le Corbusier's compositions – on the mathematical spirit of the *Modulor* and on the contrast between the harmony of nature and the intellectualism of the rules for composition, were combined with the research that Xenakis was undertaking in music on the sonorous masses, on their regular and irregular variations, and on the golden mean applied to the range of variation of any single compositional elements.

At the beginning of 1956, when the Philips firm asked Le Corbusier to design their pavilion for the Brussels World Fair, Xenakis had experimented with compositions for *Metastasis*, the graphic shape of the *glissando* drawing some continuous transformations in the sonorous space. *Metastasis* itself was strongly influenced by Le Corbusier's proportional scale arising out of the Fibonacci series and its association with the golden section.

The most evident quality of Le Corbusier's reflections regarding harmonic proportions is the consciousness that an interest on the occult aspects of the golden mean was not coherent with the scientific uses related to it, in particular its use to construct the grid for the dimensional standards for the prefabricated building "Unités". This rational attitude – more coherent with mathematical thought – appears to bring the famous French architect closer to his pupil, the young as-yet-unknown musician whose unusual and independent ideas were gaining ground in the extremes of contemporary circles of research in which Le Corbusier himself was engaged through of his involvement in several artistic fields.

The Philips Pavilion seems to sum up all the the objects *à réaction poétique* designed in the study of rue de Sèvres, freed as it was from the rigid stereometry of right angles and by the Platonism of the pure volumes [Capanna 2000]. The shape of the pavilion derives from the combination of the initial idea of a bottle containing the "nectar" of the show with Xenakis's mathematical studies on hyperbolic conoids. In October 1956 Le Corbusier's sketches were entrusted to Iannis Xenakis, who was charged to translate them through mathematics. The development of this idea into architectural form passed through a compositional process in which it is difficult to say if the mathematical structure precedes or proceeds from the architectural image. In his book *Musique. Architecture* [Xenakis 1976],[2] an entire chapter of which is dedicated to the Philips Pavilion, Xenakis makes clear how the ideas seesawed back and forth in prevalence. Xenakis's final statement at the end of his long and detailed discussion of the Philips Pavilion is:

> *For the time being only cement lies at the origin of the new architecture. It prepares the bed in which the plastic materials of tomorrow will form a river rich in forms and volumes, figures that are found not only in the biological entities but above all in the most abstract mathematics.*

This unique compositional event upholds the thesis that at the basis of some architectural events – perhaps those celebrating most completely the process of transformation of an idea from pure abstraction to factual object – were those concepts whose development is possible through the intervention of the mathematics because:

> *... some relationships between music and architecture are very easy to intuit in a confused way, delicate to specify and to define, and it is not impossible to have doubts about them, because what is aesthetic is uncertain. But they seemed to me resounding. It is clear that*

music and architecture are both arts that don't need to imitate things; they are arts in which matter and form have relate more intimately than anywhere else; one and the other address general sensibility. Both admit repetition, an omnipotent tool; both apply to the physical effects of size and intensity, by means of which they can astonish the senses and the mind, even to annihilation. Finally, their respective nature permits an abundance of combinations and regular developments that connect or compare them with geometry and analysis.[3]

The innovative logic introduced by Xenakis concerns more than only a new way of facing the problems of constructing the compositional structures, which explicitly returns to an "antique" reasoning, but which presupposes the architect's and musician's knowledge and deep intuition of the new mathematical theories connected to the problem of symmetries. No longer and not only characterized by geometric regularity – sometimes all too evident – but seen as parts of both group theory of the calculus of probabilities, it will be easier to understand asymmetry as an extension of symmetry and, more generally, in the field of probabilistic speculation, to affirm that it is impossible to improvise randomness. Thus that total liberty to which assymetry – often used as a substitute for the word 'irregularity' – would seem to allude, would not exist, because nowadays we know that even irregularity doesn't necessarily presuppose the absence of rules. It is sufficient to think of the vast production of aleatory music, deconstructivism and all those compositional phenomena in which chaotic form is the result of a patient and transient research on the actual state of the cosmos.

In the 1950s, Xenakis was developing these kind of thoughts and was asking himself first of all about rules in composition and whether is possible to produce something in music or in any other field in the total absence of rules, or in other words, in an absolutely free way. Stravinsky insisted that to make music the rules are necessary; Xenakis himself, less than ten years ago, claimed to be convinced that:

…when Bach, Beethoven or Bartók wrote their compositions they made some calculations, even though relatively simple. These dealt with calculating, preparing according to a given order, completing some operations of intellectual organization, but besides these calculations there are decisions that work to make these calculations more or less evident, to make them momentarily disappear in a game of ellipsis and then reappear [Restagno 1988].

Configured in such a way, the cardinal idea of composition turns out to be a kind of cross between the Pythagoreanism of numbers and the Parmenidean dialect, if it is analyzed from the particular point of view of Xenakis of a "future classic": the necessity, the randomness, the justice are mingled with the logic and, since the being is born from this logic, pure randomness is as impossible as non-being [Xenakis 1976: 58].

The operations through which Xenakis transferred formulas, concepts and mathematical symbols into his compositions were always dictated by a philosophical option. Immersed in the elusive climate of his hypotheses about the world and driven by a strong desire of abstraction, his works impose a passage from the calculation of probabilities to formal logic, fact that also signals a kind of retrieval of the mathematical-philosophical matrix of twentieth-century logical neopositivism. The composition, therefore, is not only a metaphor of logical processes, but a representation of them projected sometimes into the world of sounds, sometimes into that of space, or into both in unison through those complicates structures of light, space and sound called *Polytòpes*, which really are sonorous architectures born of the convergence of the physical image of the Philips Pavilion with the theoretical speculations on what is a new sonorous plastic art, with the memory of the bombardment in the campaign of Attica, the nighttime sky "striped

by the reflectors of the anti-aircraft defense and by the segmented lines of the tracing bullets…"[Restagno 1988: 39].

In these spectacular performances, conceived to involve all the spheres of perception, the related architectural space was designed to contain loudspeakers and light projectors in determined positions so that they could interact with one another. The sound and light thus projected were diffused by the internal walls of the space with studied and sometimes variable effects on the spectators and their casual disposition. These were ephemeral architectural installations that were part of experimentation with architectural continuity, carried out through the rigorous application of a mathematical-formative idea. The same structural principle is adopted for the composition of the music, which sometimes loses its meaning when it is listened to out of its spatial context, and which generally adopt the principle of variation of the density as a ideative constant, the creative potential of which have yet to be exhausted.

Further, Xenakis made his own a thesis of minimum rules, from the general law of the entropy that some years ago was studied for its expressive potential that led directly to Xenakis's simple definition of stochastic compositions:

> *As a result of the impasse in serial music, as well as other causes, I originated in 1954 a music constructed from the principle of indeterminism; two years later I named it "Stochastic Music". The laws of the calculus of probabilities entered composition through musical necessity. But other paths also led to the same crossroads first of all, natural events such as the collision of hail or rain with hard surfaces, or the song of cicadas in a summer field. These sonic events are made out of thousands of isolated sounds; this multitude of sounds, seen as totality, is a new sonic event. This mass event is articulated and forms a plastic mold of time, which itself follows aleatory and stochastic laws. If one then wishes to form a large mass of point-notes, such as string* pizzicati*, one must know these mathematical laws, which, in any case, are no more than a tight and concise expression of chains of logical reasoning. Everyone has observed the sonic phenomena of a political crowd of dozens of hundred of thousands of people. The human river shouts a slogan in a uniform rhythm. Then another slogan springs from the head of the demonstration; it spreads toward the tail, replacing the first. A wave of transition thus passes from the head to the tail … The statistical laws of these events, separated from their political or moral context, are the same as those of the cicadas or the rain. They are the laws of the passage from complete order to total disorder in a continuous or explosive manner. They are* stochastic *laws* [Xenakis 1971].

With the aid of a computer, Xenakis was able to explore the large universe of configurations based on the variation of sonorous density, in the same way in which the of material or spatial density are delineated, through the application the formulas of the calculus of probability. What was derived was an extension of an extension of the concept of entropy and the introduction of some selective operations within the statistic procedure, produced from the combination of sequential studies that govern such modifications. This has to do with the so-called Chain of Markov, an autoregressive process explored at the beginning of the twentieth century by the Russian mathematician Andrej Andreievic Markov, the constitutive mechanism of which was applied by Xenakis to compositional structures, and vaguely described in in the chapters "Three poles of condensation" and "Stochastic and Markovian Music" in *Musique. Architecture*. Thus the study of the physical behavior of sonorous phenomena opens the way for understanding the

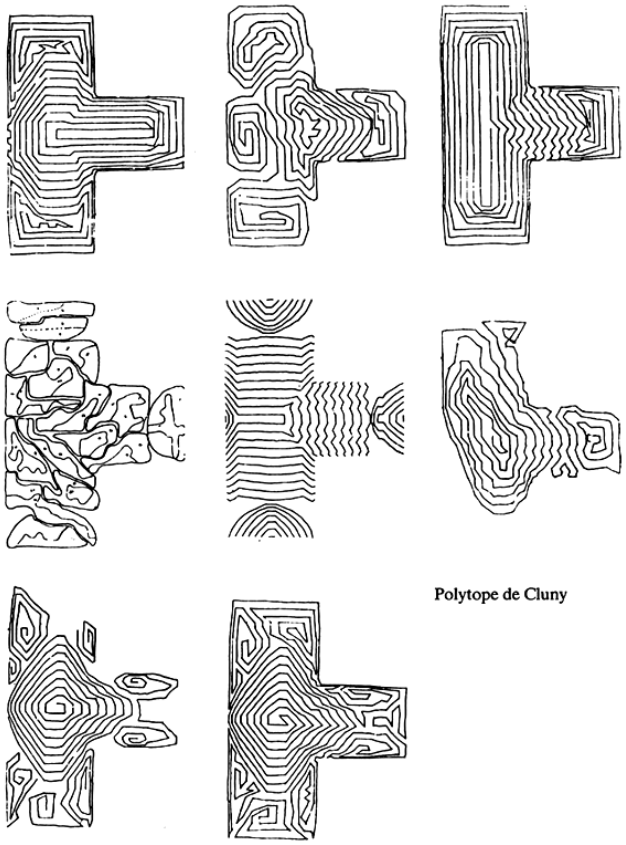


Figure 2. Xenakis's scheme for the *Polytòpe* at Cluny

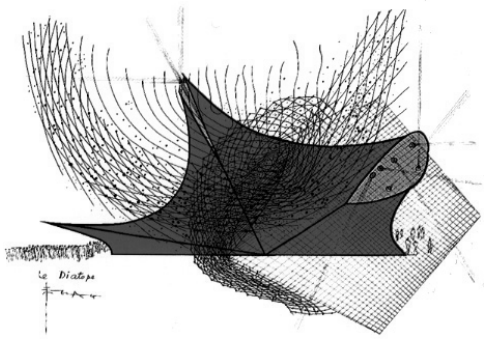


Figure 3. The Diatòpe

inner structure of the musical densities and also its adoption as a compositional paradigm for the complementary sonorous spaces.

Xenakis was interested in a concept of music that was capable of going beyond the limits of the music, both by crossing over into other expressive means – as it happened for the transformation of the graphical-musical sketches of *Metastasis* into architectural schemes for the shape of the Philips Pavilion – and through the polyaesthetic concept of the *Polytòpes* and the *Diatòpes*, as well as through techniques, often exalted by the use of the computer, that associated the graphic construction (to compose, as in writing a score) with the sonorous performance (to compose, as in producing a sonorous result). The first *Polytòpe* to be realized was that of 1967 for the French pavilion at the Montréal World's Fair, which consisted of a structure of cables kept in tension within a great anonymous space. The graphic studies of the descriptive geometry of the conoids of the layers of this introverted structure recall the preparatory sketches and models made with thread and paper constructed for the Expo of Brussels. The second *Polytòpe* was built at Persepoli in an open space. Tangled nets of bright rays created by car headlights were silhouetted against the Apadana hills; moving lights were made by students carrying electric flashlights running in random patterns, the joyful atmosphere of a late-1960s "happening". A similar performance took place in 1971 at Cluny (Figure 2). The *Polytòpe* was installed inside the Roman baths, commissioned by Michel Guy, manager of the Festival d'Automne of Paris, who initially intended to commission of Xenakis a contemporary lyric opera. In this case the net of lights, produced by 600 electronic flashes in a succession of 1/25 a second driven by a numerical series determined by the computer, which also reproduced on a digital band the music, materialized as varying traces of spiral and bright arabesques on the vault of the baths. The performance drew thousands of people because, while musical critics are often thrown off course by the stylistic extremity – and still more so by the mathematical mysteries of contemporary musical compositions and by the technological refinements of the stage realization and the combined effects of light and sound – lay people let themselves be carried away by their senses, thus entering into a perfect syntony with Iannis Xenakis's message, which has always been that of a young Athenian in the times of the civil war, the sorcerer's apprentice at Le Corbusier's forge, only apparently taken in by the new and instead fond of an ancient philosophy.

The *Diatòpe* (Figure 3), which appears to take up once more the studies that began in Le Corbusier's Atelier and represents a kind of conclusion to this long first phase of on the work frontier, was built in front of the Beaubourg, the famous Center of contemporary art of Paris. Xenakis came up with various conceptions for this project (Figure 4), but the one that was realized consisted of a tent of 1000 square meters of semi-transparent red vinyl, so that the performance was visible also from the outside. This shell has the more or less simplified form of the Philips Pavilion and contains the representation of the "Légende of Eer", the myth taken from the Plato's *Republic* that narrates the return from the world of the departed. Thus the ancient world lived again in a building born from a kind of mathematical translation of the structural problem originally meant as propaganda for technology. Ancient literature is put into music through systems considered extreme by some, but when seen through the eyes of those who ask themselves if a kind of synthesis of the arts is possible, or better, a synthesis of all forms of expression, they seem to present Xenakis as a patient and scientific researcher who set the standards for a musical composition based on mathematics, on set theory, on logic, without falling into the trap of treating such principles as an end in themselves, as pure enjoyment of an arid intellectualism.

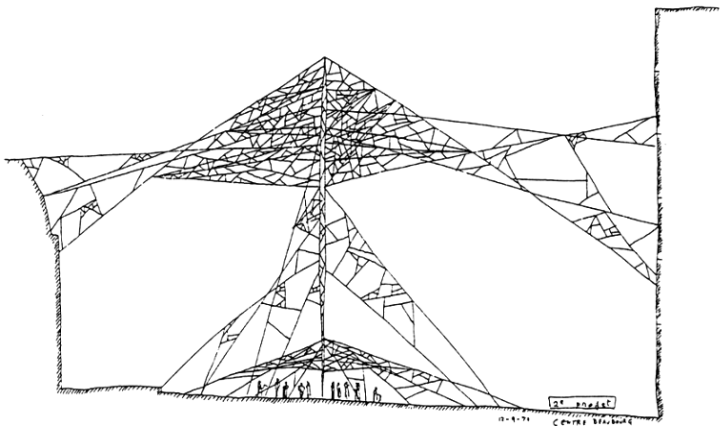


Figure 4. The second project for the Centre Beaubourg

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Notes

1. Xenakis was born in Braila (Romania) on 29 May 1922 to Greek parents. He studied at the Polytechnic of Athens and then, with Olivier Messiaen, at the National Conservatory of Paris. He invented the idea of musical masses, of stochastic music and of symbolic music through the introduction of the calculus of probability and set theory in the compostion of instrumental, electro-accoustic and computer music. As architect, during his period of collaboration in Le Corbusier's Atelier he designed the ruled surfaces of the Philips Pavilion and the glass-windows of the Convent of La Tourette; afterwards he invented the *Polytòpes* in order to install his performances. The *Polytopes* are architectonical and musical installations made with light and sound, which require simultaneous composition of the space and of the music. In 1965 he founded the Centre Mathématiques Musicale of Paris; from 1967 to 1977 he taught at the University of Indiana at Bloomington, where he founded the Center of Mathematical and Automated Music; in 1975 he was Gresham Professor of Music at the City University of London and Professor at the Sorbonne of Paris from 1972 to 1989. In 1962 he wrote *Formalized Music*, which investigates the use of mathematics in composition.
2. The two parts of the book are decidedly distinct, but in each, concerning only works by the author alone or in collaboration, is described the expression of the mathematical process governing the composition. Of particular interest are those pages at the end of the book, summing up the correspondence between the mathematical conquests and the parallel development of musical composition.
3. Paul Valéry, "Storia di Anfione", *Scritti sull'arte*, Milan, 1984. Amphion was the son of Jupiter and the queen of Thebes, player of the lyre to whom the extraordinary history of the construction of the walls of Thebes is attributed. The myth emphasizes the creative and regulating power of music and portrays the great artist dominating music and architecture.

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About the author

Alessandra Capanna is an Italian architect living and working in Rome. She has taken her degree in Architecture at University of Rome "La Sapienza", from which she also received her Ph.D, discussing a thesis entitled "Strutture Matematiche della Composizione", concerning the logical paradigms in music and in architecture. She is the author of *Le Corbusier. Padiglione Philips, Bruxelles* (Universale di Architettura 67, 2000), on the correspondence between the geometry of hyperbolic paraboloids and technical and acoustic needs, and its final and aesthetics consequences. Among her published articles on mathematical principles both in music and in architecture are "Una struttura matematica della composizione", remarking the idea of self-similarity in composition; "Musica e Architettura. Tra ispirazione e metodo", about three architectures by Steven Holl, Peter Cook and Daniel Libeskind; and "Iannis Xenakis. Combinazioni compositive senza limiti", taken from a lecture given at the Dipartimento di Progettazione Architettonica e Urbana at the University of Rome.